

WHAT IS CLAIMED IS:

1. A water treatment apparatus comprising
a plurality of composite reverse osmosis membrane modules arranged in
multi-stages,
each of the plurality of modules including a porous support and a
polyamide skin layer formed on the porous support,
the plurality of modules including a final-stage module and at least one
pre-final module,
wherein a selected portion of permeated water obtained from the at least
one pre-final module is supplied to the final-stage module, and
a rest of the permeated water is discharged from or recovered in the
apparatus along with permeated water obtained from the final-stage module.
2. The water treatment apparatus according to claim 1,
wherein the permeated water from the final-stage module and the
permeated water that is not supplied from the at least one pre-final module to
the final-stage module are mixed with each other to be discharged or
recovered.
3. The water treatment apparatus according to claim 1,
wherein a ratio (A : B) of an ion concentration (A) of the permeated water
supplied to the final-stage module and an ion concentration (B) of the
permeated water that is not supplied to the final-stage module is in a range of
1 : 2 to 1 : 10.
4. The water treatment apparatus according to claim 1,
wherein the permeated water supplied to the final-stage module is
adjusted to be alkaline.
5. The water treatment apparatus according to claim 4,
wherein a pH of the permeated water supplied to the final-stage
module is in a range of 8 to 12.
6. The water treatment apparatus according to claim 1,
wherein the permeated water supplied to the final-stage module is
discharged from a concentrate side of at least one pre-final module supplying

the permeated water to the final-stage module.

7. The water treatment apparatus according to claim 1 further comprising a pressure vessel

5 wherein a plurality of pre-final modules are provided as the at least one pre-final module,

each of the plurality of pre-final modules is a spiral module formed by winding a composite reverse osmosis membrane around a water-collecting pipe,

10 the plurality of pre-final modules are connected with each other by connecting their water-collecting pipes,

the plurality of pre-final modules thus connected are contained in the pressure vessel,

raw water to be treated is supplied to and permeated water is discharged from one end of the pressure vessel,

15 concentrated water and permeated water are discharged from the other end of the pressure vessel, and

the permeated water discharged from the other end is supplied to the final-stage module.

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8. The water treatment apparatus according to claim 7,

wherein an interior space of the connected water-collecting pipes is divided into two separate spaces by a partition to separate permeated water on a raw water side and permeated water on a concentrate side.

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9. The water treatment apparatus according to claim 1 further comprising a plurality of pressure vessels arranged in multi-stages,

the plurality of pressure vessels including a first-stage pressure vessel and at least one pressure vessel subsequent to the first-stage pressure vessel,

30 wherein a plurality of pre-final modules are provided as the at least one pre-final module,

each of the plurality of pre-final modules is a spiral module formed by winding a composite reverse osmosis membrane around a water-collecting pipe,

35 the plurality of pre-final modules are connected with each other by connecting their water-collecting pipes,

the plurality of pre-final modules thus connected are contained in the

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plurality of pressure vessels,

- the first-stage pressure vessel is supplied with raw water to be treated,
the at least one pressure vessel subsequent to the first-stage pressure
vessel is supplied with concentrated water discharged from at least one
preceding pressure vessel, and
the final-stage module is supplied with permeated water discharged from
the at least one pressure vessel subsequent to the first-stage pressure vessel.

- 5 10. The water treatment apparatus according to claim 9,
wherein three pressure vessels are arranged in three stages, and
permeated water from a second-stage pressure vessel and/or a third-stage
pressure vessel is supplied to a final-stage composite reverse osmosis
membrane.
- 15 20. 11. The water treatment apparatus according to claim 1,
wherein the at least one pre-final module has a salt rejection of at
least 99% and a permeate flux of at least $0.2\text{m}^3/\text{m}^2 \cdot \text{day}$ when the apparatus is
operated using as a feed solution a 3.5wt% salt water at a pH of 6.5, a water
temperature of 25°C, and an operational pressure of 5.5MPa.
- 25 12. The water treatment apparatus according to claim 1,
wherein the at least one pre-final module has a salt rejection of at
least 99.5% and a permeate flux of at least $0.3\text{m}^3/\text{m}^2 \cdot \text{day}$ when the apparatus is
operated using as a feed solution a 3.5wt% salt water at a pH of 6.5, a water
temperature of 25°C, and an operational pressure of 5.5MPa.
- 30 13. The water treatment apparatus according to claim 1,
wherein the at least one pre-final module has a boron rejection of at
least 80% when the apparatus is operated using as a feed solution a 3.5wt%
salt water containing 5ppm of boron at a pH of 6.5, a water temperature of
25°C, and an operational pressure of 5.5MPa.
- 35 14. The water treatment apparatus according to claim 1,
wherein the at least one pre-final module has a boron rejection of at
least 90% when the apparatus is operated using as a feed solution a 3.5wt%
salt water containing 5ppm of boron at a pH of 6.5, a water temperature of
25°C, and an operational pressure of 5.5MPa.

15. The water treatment apparatus according to claim 1,
wherein the final-stage module has a salt rejection of at least 98% and
a permeate flux of at least $0.5\text{m}^3/\text{m}^2\cdot\text{day}$ when the apparatus is operated
using as a feed solution a 0.05wt% salt water at a pH of 6.5, a water
temperature of 25°C, and an operational pressure of 0.75MPa.

16. The water treatment apparatus according to claim 1,
wherein the final-stage module has a salt rejection of at least 99.0%
and a permeate flux of at least $0.7\text{m}^3/\text{m}^2\cdot\text{day}$ when the apparatus is operated
using as a feed solution a 0.05wt% salt water at a pH of 6.5, a water
temperature of 25°C, and an operational pressure of 0.75MPa.

17. The water treatment apparatus according to claim 3,
wherein a concentration of total dissolved solids (TDS) in the raw water
supplied to the apparatus is at least 1wt%.

18. The water treatment apparatus according to claim 17,
wherein the raw water supplied to the apparatus is seawater

20 19. The water treatment apparatus according to claim 3,
wherein the raw water supplied to the apparatus is seawater, and a
concentration of boron in permeated water discharged from or recovered in
the apparatus is 1mg/l or less.

25 20. The water treatment apparatus according to claim 1,
wherein the polyamide skin layer in the at least one pre-final module
has contains bromine atoms.